Tackling the Application Gap: Architecture Students' Experiences of a Research Component in a Design Studio Class

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Tackling the Application Gap: Architecture Students' Experiences of a Research Component in a Design Studio Class

by

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Abstract

Prominent architects have made calls for the architecture profession to adopt a new level of scientific rigour and more readily incorporate evidence-based design into practice; similar to medicine's evolution to evidence-based medicine. However, evidence-based design is a relatively new field and its widespread adoption by the profession is challenging. One challenge is associated with the education of architecture students. Students, if they are taught about research, often face an 'application gap' between research classes and design studio classes. In this study, a research component was implemented in a design studio class. Students were observed and interviewed about their experiences. The research component was successful in introducing students to evidence-based design; however, it did not offer a comprehensive education. Students responded favourably to the research component. We summarize their experiences in the class, draw links to the field of medicine, and offer recommendations for the education of architecture students.

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Every science touches art at some points – every art has its scientific side; the worst man of science is he who is never an artist, and the worst artist is he who is never a man of science. (Trousseau, 1869).

Chapter 1 … Introduction

In 1984, Roger S. Ulrich's famous study 'View through a window may influence recovery from surgery' was published in *Science* and covered by the media. This study demonstrated that patients recovering from surgery in rooms with windows that had views of trees had shorter hospital stays, took fewer medications, had less postsurgical complications, and were evaluated more positively by nurses than those who stayed in rooms with views of a brick wall.

Now, based on this study and others like it, healthcare architects are likely to pay careful attention to the views from hospitals they plan. This process, of using scientific results to inform design decisions, is called evidence-based design. Hamilton and Watkins (2009) offer this definition: "Evidence-based design is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project".

In this paper, I will discuss the ongoing adoption of evidence-based design by the architecture community. I will start by discussing the history of evidence-based medicine, as it offers useful parallels to evidence-based design. I will then discuss evidence-based design and the role architecture education plays in the field. Then, I will introduce the current study and provide an analysis and discussion of the results. Finally, I will make recommendations and discuss limitations and future research.

It is important to note that in order to stay within the scope of this project, the focus of this paper is not on the merits of evidence-based design, but rather the adoption of evidence-based design by the architecture community.

1.1 Evidence-based Medicine

To understand the future of architecture, it is helpful to examine the history of medicine. Like architecture, medicine is often considered an 'art' (Saunders, 2000; Panda, 2006); however, over time medicine has become increasingly rigorous, with a dependence on the scientific method and large randomized control trials.

The term "evidence-based medicine" was first published in 1991 by G.H. Guyatt, in relation to individual decision-making and education. Guyatt and his colleagues focused on how to educate clinicians to use evidence and research in their care of individual patients, such as teaching clinicians how to search research literature and apply it to their treatment plans (Evidence-Based Medicine Working Group, 1992). In 1997, David L. Sackett put forth what is now the most commonly cited definition of evidence-based medicine, stating that it is "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research" (Sackett, 1997).

David M. Eddy (1990) advocated for a similar idea applied to health care guidelines and policies, rather than individual clinicians. He suggested that policies be based not "subjective judgment or consensus", but rather on evidence (Eddy, 1990). In

later articles, he further explained his position, discussing the limitations of expert opinion, the use of guidelines in decision making, and the importance of following a systematic process. Eddy called this approach to medicine "evidence-based guidelines" (Eddy, 2005), and later proposed a definition of evidence-based medicine as "… a set of principles and methods intended to ensure that to the greatest extent possible, medical decisions, guidelines, and other types of policies are based on and consistent with good evidence of effectiveness and benefit" (Eddy, 2005).

Taken together, Sackett's and Eddy's definitions of evidence-based medicine offer an approach of using evidence-based medicine at all levels of the healthcare system, from individual practitioners to policy makers, and indeed, this is what we see the healthcare system today.

However, there are criticisms of evidence-based medicine, especially recently. Current criticisms center around narrow definitions of evidence and unsubstantiated extrapolations of research to clinical practice. In the name of evidence-based medicine, clinicians can face inflexible rules that are not suitable for individual patients with different combinations of ailments and unique situations. Greenhalgh, Howick and Maskrey (2014) call for a return to 'real evidence-based medicine', which they say uses expert judgment over mechanical rule following and is patient-centric, placing patient-care as the top priority and involving the patient in decision-making. This criticism highlights the need for professional judgement to temper the dogmatic application of evidence-based practice.

Despite these critiques, today, medicine is near synonymous with evidence-based medicine, and evidence-based practice is common place in other fields as well, such as in dentistry, education, nursing, business management, and psychology.

1.2 Evidence-based Design

Architecture has been affected by this movement, as many see evidence-based design as the future of the profession. Around the time that evidence-based medicine was being defined in healthcare, the first studies on hospital environments and their impact on patient health were being conducted, such as Ulrich's study mentioned earlier, 'View through a window may influence recovery from surgery'. Building off this study and others like it, in 1993, the Center for Health Design was established, with a mission to advance "a single idea—that the design could be used to improve patient healing in healthcare environments" (Alfonsi, Capolongo, & Buffoli, 2014). In 2004, the Center for Health Design defined evidence-based design as "the deliberate attempt to base building decisions on the best available research evidence with the goal of improving outcomes and of continuing to monitor the success or failure for subsequent decision-making". They further defined evidence-based design as including these steps: "(1) define evidence-based goals and objects; (2) find sources for relevant evidence; (3) critically interpret relevant evidence; (4) create and innovate evidence-based design concepts; (5) develop a hypothesis; (6) collect baseline performance measures; (7) monitor implementation of design and constructions; and (8) measure post-occupancy performance results". Hamilton and Watkins (2009) also described an evidence-based design process that could be used by a design firm (Table 1).

Table 1.

Nine-step Evidence-based Design Process.

Task		Activity
1	Identify the Client's Goals	Note most important and facility-related global and project-based goals
2	Identify the Firm's Goals	Understand the firm's strategic, project and evidence-based design objectives
3	Identify the Top 3-5 Key Design Issues	Narrow the possible choices; work on high impact decisions
4	Convert Design Issues to Research Questions	Reframe statement of design issues to become research topics
5	Gather Information (Benchmark Examples, Literature Sources, Internal Studies)	Infinite possibilities must be narrowed; limited perspectives must be expanded
6	Critical Interpretation of the Evidence	No direct answers; requires open-minded creativity, balance, and critical thinking
7	Create Evidence-Based Design Concepts	Based on creative interpretation of the implications of research findings
8	Develop Hypotheses	Predict the expected results of the implementation of your design
9	Select Measures	Determine whether your hypothesis is supported

Architects can engage with the steps in Table 1 to varying degrees, each with increasing levels of rigour (Hamilton, 2009). "Level 1 practitioners", as Hamilton calls them, stay current with the literature in their field, interpret evidence that relates to their projects, and design accordingly. Level 2 practitioners hypothesize outcomes of their evidence-based design decisions, and then measure the results. Level 3 practitioners follow the paths of Level 1 and 2 practitioners, and then publicly report their results. Level 4 practitioners, or "scholar-practitioners" go a step further than

Level 3 practitioners and submit their work for academic publication, which subjects it to rigorous review.

The first architects to use evidence-based design were healthcare architects who were inspired by the evidence-based medicine movement. In healthcare architecture, the benefits of evidence-based design became clear. For example, in 2008, Ulrich and colleagues published a comprehensive review of the research literature on evidence-based healthcare design, and found "a growing amount of sound research to support the application of certain specific design characteristics to improve healthcare outcomes" (Ulrich, et al., 2008).

As evidence-based medicine and design progressed, there began to be growing pressure from clients to adopt this approach. As Cama (2009) notes, there is no greater driver than market demand. Indeed, now healthcare design is synonymous with evidence-based design, a move that was essential to maintain credibility in the healthcare industry (Cama, 2009).

Today, some architects have called for the architecture profession to adopt evidence-based design more generally, in non-healthcare projects. Proponents of this approach have argued that the architecture profession requires a new level of scientific rigour, one that could be provided through using scientific evidence to inform design decisions. This is not to imply that architects have never used evidence. For example, industrial design has a long history of user research and human centered design—while not called evidence-based design, the processes are similar (Hanington, 2003). As another example, post-occupancy evaluations, which have long been used in

architecture, are strikingly similar to '*n*-of-1 trials' in medicine. A post-occupancy evaluation examines the effectiveness of a single environment after it has been used for a time (Zimring & Reizenstein, 1980). In *n*-of-1 trials, single cases are also used as learning tools (Guyatt, et al., 1990).

Hamilton and Watkins (2009) explain that while architects have always used evidence, relying on "engineering science, statics, strength of materials, geometry, physics, soil mechanics, construction law and real estate economics", today's architects would be well-served by searching for evidence from other fields as well, such as medicine and psychology. While Hamilton is a healthcare architect, his book with Watkins, *Evidence-Based Design for Multiple Building Types*, espouses the use of evidence-based design outside of healthcare; for example, in workplace, retail and learning environments. They assert that the use of evidence-based design is useful for practitioners, clients, and the overall profession of architecture. They propose that practitioners who use evidence-based design will produce higher quality projects, clients of these practitioners will save money and see projects better suited to meet their goals, and as these types of practitioners increase, the profession will be seen as more trustworthy and credible.

Advocates of evidence-based design also come from fields other than healthcare. Brown and Corry (2011) encourage the use of evidence-based design for landscape architecture, and Guerin and Thompson (2004) its use in interior design. In their book 'Design Informed: Driving Innovation with Evidence-Based Design', Brandt, Chong and

Martin (2010) argue that the only way for the profession of architecture to thrive and remain relevant is to embrace evidence-based design.

However, as a new field, the widespread adoption of evidence-based design by the architectural profession faces barriers. Martin (2009) notes several obstacles that designers may encounter when trying to implement evidence-based design. First, designers and firms must *want* to engage in evidence-based design. This type of design can clash with a culture of normative design. Individual designers wanting to incorporate research may encounter resistance from colleagues, and firm leaders who want to shift the design process of a firm may face disgruntled employees. Then, once the desire for evidence-based design is established, designers and firms need the resources to engage in evidence-based design. These resources include human resources—people who have the skills and knowledge required—as well as monetary resources, to pay for the additional steps in the design process.

In a survey of non-healthcare design firms, Martin (2014) found that architects were not confident they had the skills and knowledge to use evidence-based design. This is unsurprising, given that this approach is often not taught to architecture students.

1.3 Architecture Education

There is little formal research on evidence-based design education, especially in non-healthcare areas, but there are many academics and professionals calling for increased research and educational reform, stating that research education is essential to moving the architectural profession forward (Viets, 2009; Brandt, 2010; Brown &

Corry, 2011). Guerin and Thompson (2004) talk about the need for an educational transformation in interior design:

> "Above and beyond the currently recognized curriculum requirements for the first professional degree, we must prepare future design to practice with the breadth and depth of knowledge required to solve complex interdisciplinary problems of human behaviour and design. This education must prepare future practitioners to implement evidence-based design criteria into the design process and thus improve the quality of the designed environment. Educators must be prepared to teach future practitioners the value of research that adds to the body of knowledge. Thus, the bridge between practice and education can be strengthened, in turn sustaining the profession and providing the foundation for an academic discipline."

These calls echo the process seen in medicine, where the education of medical residents is seen as crucial for evidence-based medicine (Guyatt, 1992). Viets (2009) notes that medical students need to be familiar with research methods before even being admitted to medical school, and then once admitted, they are further educated about medical research—how it is conducted, how to evaluate it, and how to apply it to patient care.

Brown and Corry (2011) apply this idea of research education to architecture, stating that "professors need to develop and teach their students processes for accessing and using evidence as a basis for their design projects (design boards should cite evidence!)". However, educating students about evidence-based design may require a cultural shift.

Architecture students are typically not taught how to conduct research or how to use peer-reviewed literature for their projects, and even if students are taught about evidence-based design, there can be an 'application gap' between research classes and design studio (project-oriented) classes. Gross and Do (1997) emphasize that in architecture education, "studio is king", and it can be difficult to integrate material from lecture classes into the hands-on experience of a design studio class. They go on to explain that in the studio, "Often an emphasis on original and 'creative' designs outweighs designs that work (serve functional requirements, are buildable, etc.) Students imitate the style of fashionable architects without understanding the implications for users of the appropriateness for local context. And less experienced students view architectural design as an opportunity to express their inner creative urges, rather than as a challenge to resolve a complex set of technical and social issues" (Gross & Do, 1997). Evans (2009) explains that there are really two distinct cultures in architecture education, the "analytic lecture theatre and the conjectural design studio" (p. 237).

Sancar (1996) talks about how this gap can frustrate both students and instructors when, despite required courses and literature reviews, students struggle to integrate facts and research findings into their designs. Sancar goes on to give structural, epistemological and methodological reasons explaining why the application gap exists. Structurally, she makes a 'two communities argument' where design professionals and research scientists exist in two different spheres. There can be a lack of incentive for research and interdisciplinary collaboration in professional

departments, and there are neither design professionals who conduct research or scientists trained in design. The epistemological reason questions the relevancy of scientific knowledge. Positivist epistemology defines legitimate research findings as those supported by measurable, objective facts. These types of findings can be limited in their application to design, as they do not necessarily address practical questions or deal with the unique aspects of a project. Finally, there are methodological reasons for the gap. Researchers expect the design process to be linear and organized like an information processing model, but this is different from the design process that often occurs in practice (Sancar, 1996).

There are different strategies to address these structural, epistemological and methodological difficulties. One example is offered by Haq and Pati (2010) who developed an evidence-based design studio class to examine how designers interact with evidence. Their study also demonstrates what a class with both research and design components might look like, as their class had three sections: (1) knowing a hospital (the project was to design a general hospital); (2) knowing the evidence; and (3) designing with knowledge and evidence. The class also involved two 'outside' experts; one an expert in nursing and another in healthcare design research. By the end of the course, students' perceived knowledge about healthcare design grew by almost 70% and students expressed an increased appreciation for evidence-based design. Students also benefited from the availability of experts.

While Haq and Pati (2010) demonstrated the utility of using evidence-based design in a studio to design a hospital, it is likely that these benefits would extend outside of healthcare design and could be used in studios focused on other areas.

1.4 Current Study

For the current study, we explored students' experiences of a design studio class with a research component. We asked how a class like this could help bridge the application gap, and if it would better equip students to apply evidence-based design principles in their practice of architecture. Students in a one-semester design studio class at the University of Calgary were introduced to evidence-based design through a research component incorporated into the class. For this studio, eleven architecture students were tasked with redesigning a prototype home for aging-in-place. The first prototype of the home, the Laneway House, was built previously. Students in this studio then used feedback on the Laneway House to design and build a second-generation prototype, called the Garden Loft.

Although a residential design, a home for aging-in-place is a useful introduction to evidence-based design as there are healthcare components and students can benefit from the large body of knowledge about healthcare design. However, as the home is primarily residential, the project allows for the examination of the use of evidence-based design outside of healthcare.

Chapter 2 … Method

2.1 Participants

Participants were eleven graduate architecture students in their final semester at the University of Calgary. These students were recruited for the study as they selected their design studio class for the semester. In this architecture program, students are given a choice of which studio class to take. Students were informed that there was a Master's student who would be implementing a research component in a certain class. If they chose to take the class, they would be invited to participate in research evaluating the effectiveness of this teaching intervention.

All eleven students who registered in this studio class agreed to participate in the research and be observed through the semester.

2.2 Procedure

Upon registering in the course, each student was invited to participate in this research. If they agreed to do so (which all students did), they signed an informed consent document and took a short survey about their current knowledge of research methods and evidence-based design.

For the rest of the semester, students were instructed by an architecture professor as they normally would be, and the class worked together to re-design the Laneway House. In addition, there were several components that focused on evidence-based design:

First, students were introduced to the idea of evidence-based design, as many of them were unfamiliar with the term. This introduction was done through a two-hour

lecture in the first week of class. The lecture covered the following topics: the history of evidence-based design and its roots in evidence-based medicine, the scientific method, the process of evidence-based design, case studies of evidence-based design in practice (from original research to design implications), how to evaluate if research is credible, and how to find research evidence in academic literature.

At the end of the lecture, students were asked to find a research article that would be useful for designing the home. Later, we discussed their findings and brainstormed ways those findings could be incorporated into the home.

Students attended lectures from experts in other fields; for example, a professor specializing in the psychology of aging, a gerontologist, and a specialist in chronic disease prevention and management. These guest lecturers instructed students on the physical and psychological changes associated with aging and ways that physical designs of homes could support older adults.

The primary source of evidence used in the class was research data gathered from the first prototype home, the Laneway House. This home was studied by researchers at the W21C, a research and innovation centre based out of the University of Calgary. Seniors and occupational therapists were given a tour through the home and asked to engage in a "think aloud" exercise, meaning that as they viewed and interacted with each room of the house, they were asked to vocalize any thoughts they had about the space. These tours were audio-recorded, transcribed and anonymized, and then this data was given to the students. Together, we reviewed this data. We also took this opportunity to further discuss evidence-based design. Students were subsequently

encouraged to use the data to inform their design decisions about the new, second-generation prototype, Garden Loft house.

Finally, students were engaged in the early stages of researching the Garden Loft. They were taught about the iterative process of evidence-based design, and before building the house, mocked up the space with tape. This low fidelity simulation allowed them to test the layout of the house, for example to examine wheelchair clearances.

These interventions were primarily conducted during the first half of the semester, and students were observed to explore how they responded to the research components. Later in the semester, students were required to build the house, and the focus of the class shifted almost completely from design and research to construction.

In the last week of classes, each participant was interviewed individually. Interviews were semi-structured. Semi-structured interviews go through a list of pre-determined questions, while leaving room for participants to raise issues not previously anticipated (Braun and Clarke, 2013). Participants were asked a series of questions about their experiences in the class and their perceptions of evidence-based design. See Appendix for the full list of interview questions.

Interviews were then transcribed, anonymized, and imported into NVivo 11, a qualitative analysis software developed by QSR International. NVivo allows researchers to code data; that is, to assign blocks of text to categories the researcher creates. These categories help guide the researcher in further analysis. Using NVivo, the interviews were coded and then thematically analysed.

The researcher also attended classes throughout the semester and made notes and observations of the class. These notes were also thematically analysed along with the interviews.

A thematic analysis is "a method for identifying themes and patterns of meaning across a dataset in relation to a research question" (Braun and Clarke, 2013). The thematic analysis was a theoretical thematic analysis, where the "analysis is guided by an existing theory and theoretical concepts"; in this case, the idea that there is an 'application gap' in architecture education and that a research component in a design studio class could help bridge the gap. The researcher looked for patterns from the interview data and class experiences to form conclusions about these ideas.

Ethical approval for this study was obtained through the University of Calgary's Research Ethics Board.

Chapter 3 … Analysis and Discussion

The purpose of the study was to explore students' experiences of a design studio class with a research component. Specifically, we were interested in how a class like this could help bridge the application gap, and if it would better equip students to apply evidence-based design principles in their practice of architecture.

In our analysis, several themes arose that relate to these research questions. Students' experiences of a design studio class with a research component was characterized by its difference from other studio classes, what they learned about professional architecture work, and the inclusion of evidence-based design. Students also discussed effective and ineffective aspects of the class.

In terms of the application gap, themes arose about students' lack of research knowledge and experience, and the frustrations surrounding actually implementing research findings.

For equipping students to apply evidence-based design principles in their practice of architecture, themes arose about students carrying principles they learned forward.

Each theme is described in Table 2.

Table 2.

Theme definitions.

Research Question	**Theme**	**Definition**
Class experience	Difference from other studios	Comments that discussed other studio classes at the University of Calgary
	Professional work experience	Comments that discussed professional work experiences
	Value of evidence-based design	Comments that discussed the value of evidence-based design
	Effective/ineffective components	Comments on specific components of the class that students noted were effective/positive or ineffective/negative
Bridging the application gap	Lack of research knowledge/experience	Comments that note students' knowledge about research
	Frustrations with implementation	Comments about students' frustrations with implementing evidence-based design
Changing architecture practice	Value of evidence-based design in the future	Comments about students' intent to use evidence-based design in the future

As noted by Braun and Clarke (2013), many qualitative research reports benefit from combined analysis and discussion sections. This paper will follow that approach, and draw from the relevant literature to expand the analysis of each theme.

3.1 Class experience

3.1.1 Difference from other studios

In this theme, students discussed the other studio classes they took throughout their degree, and how this studio was unique. Students described their other studio classes as homogenous in content and appreciated the opportunity to learn something new in this class. One student said:

> *"I feel like the six studios that we have throughout the whole program, if I wasn't in this particular one, would have been the exact same. […] They're just different things in terms of program, but they're exactly the same in terms of concept. It's very difficult to be like well, I'm actually learning something. It felt like I was literally just repeating it."*

Students then discussed the differences in content between the Garden Loft studio class and their other classes. Students felt that one important factor was the inclusion of research and guidance from experts, which they felt resulted in a final project that was more robust. One student said, *"In other studios, a lot of times we're kind of guessing and you don't know how to make a decision, in some ways. And so you're kind of, I don't know, you never really know if what you're doing is the right thing."* Another student offered an example of a project they felt would have been well-served by more research:

> *"I wish that every studio would bring in people from the type of building that we're designing, so that we could actually learn some more factual information. My first project was an interpretive centre, and we didn't even understand the programs. It would be cool to have people come in to explain what you need when you're presenting that type*

of information, or what an interpretive centre even is and the importance of it, so that you know what you're designing for."

When talking about research, students expressed a desire for all studios to include a research component, made clear by comments like, *"I think that [research] would have been a cool component in every studio"* and *"I think it [research] should be done all the time. At least one studio should have it in every year."*

3.1.2 Practical experience

Students felt that this class offered them practical experiences that were similar to what they would encounter in the professional world. Over half the students explicitly mentioned choosing the class because of its design-build aspect. They appreciated the opportunity to build something they designed and the hands-on aspect of the project. Many students also talked about the practical applications of the project. These motivations are well-represented in one student's comment:

"I wanted to be a part of something actually practical, because [the professor] mentioned that it would be kind of like, you would use it in real life, like it was actually something that would be used in Calgary. And it's something that's tangible. Usually in architecture you think up something completely abstract and wonderful and really, really fun to do, but I've done that so much in my past years that this time I wanted to actually build something and construct something."

At the end of the class, students felt they were well-served in terms of gaining practical experiences. One student shared this comment:

"Moving forward, I feel like I will be a lot more ready to get back into the workforce and be able to send out good emails, to be able to go on site, feel confident I know how to be safe, as well as, know the, b/c architecture has its own lingo, and construction has its own lingo, and being able to correspond and get to know the DIRTT guys definitely has increased my construction lingo, if that makes sense. I feel confident, a lot more confident, moving forward that I'm not going to be a fish out of water."

3.1.3 Value of Evidence-Based Design

Students discussed learning about evidence-based design and gaining an appreciation for and evidence-based design approach through this class. One student said:

"Very helpful. It's [evidence-based design] excellent. We talked a lot about it too, like between [some of my classmates]. It's really helpful, just having that base of research was something to pull from. Half the time you're just imagining things and you don't have anything to go off of, and if you don't know anything about the subject […] But what do people, having people's raw data even, is just perfect. Because it will create like a little idea and then you'll go with that idea and see if it works and then you can test it. […] Having that information and then having the ability to do something with it, rather than having it just sit there was really cool."

Students talked about specific experiences with evidence-based design:

"Oh, it was so important, like, if we didn't have a research component, we would have designed a completely different building. And it would not have been as successful as this one, right. We would not have learned, high contrast, we would not have learned about

> *okay, let's site the building on site so that elderly people don't have to walk on snow, like little things like that that came from research and discussion at the inception of the project were so, so important."*

One thing many students appreciated about evidence-based design is how it made them more aware of the people who would be using the building after it was designed. They interpreted this process as opening their minds and understanding that their personal biases and preferences would not necessarily serve their clients well. This idea was captured by one student who said:

> *"Because you're so focused on understanding what's happening to the space and how you're reacting to it, you're not really considering other people until you look at how they're starting to interact with it and you see that it's not okay. I think that was hugely beneficial, was taking your mind frame out of your own self and having to apply it to other people."*

Other students echoed this sentiment, saying, *"I think that it's being able to look at things from more than just an outsider, exterior perspective. In terms of like the actual user groups that are going to be in these spaces."* And another, *"You're not as close-minded. You don't feel like you're restricting people in the space you're designing because you're going to be the way you are. I think that was a huge thing I couldn't have got from any other studio."*

Another student noted the potential consequences of not engaging in evidence-based design, and tapped into the idea that ultimately clients pay the price of an architect's decisions:

> *"Just kind of being more in tune with the way that design affects people and the way that they use the space. I think that's kind of important and I think there's probably not enough emphasis on it in design and probably a lot of buildings get built that probably don't meet the needs of the people that are meant to use them."*

This comment reflects one of the largest drivers of evidence-based design: client demand. Cama (2009) notes that while clients may not realize what they are asking for is called 'evidence-based design', they do want architects to provide well-researched justifications for their design decisions.

While students received feedback on the house from real-life end-users, such as elderly adults and occupational therapists, they were not able to directly engage with these people. This was because these end-users were recruited as participants in a study, and ethics meant only the research team could interact with them. Instead, students received anonymized transcripts of interviews with the participants detailing their opinions on the home. Some students expressed a desire for direct interaction, but understood that ethics would make this difficult. However, even without direct intervention, these students still felt that the opinions of the end-users were incredibly valuable for the design process.

Evidence-based design was also seen as more beneficial than other types of 'research'. In this class and in their other classes, students often looked at design precedents, and this was seen as a type of research; however, students also recognized the increased value in evidence-based design. One student noted in particular the element of iterative testing, saying:

"We do research on a less professional basis, […] in pretty much any project we do, like we look at precedents, we look at articles that have been written about certain [buildings]. Like if we design an arena we look at dozens of arenas. So I guess you could to some degree call that research. But in this case, I think it's really important to now test the prototype that we have, like how much does it meet the criteria we have based off that research. I think that is really important for the research process."

Indeed, looking at precedents is not evidence-based design. Rather, it is what Martin (2014) calls 'normative design', "principally comprised of what has been done before, commonly referred to as 'best practices' and manifested in decision-making characterized by statements such as 'I have seen it done before', 'I think it will work', 'I have always wanted to try it' or 'My colleague told me about it'." While students were familiar with this type of research, they were not familiar with academic literature, the scientific method, or the process of evidence-based design, prior to taking this class.

3.1.4 Effective/ineffective components of the class

The students mentioned that they found the following components of the class effective: getting feedback from the previous design, interacting with researchers, iterative testing, guest lectures from experts, and looking up research articles.

The component most frequently mentioned by students as effective was getting feedback from the previous design, with comments like this: "*I would have to say that the most beneficial part of it for what we have created today was actually based on the feedback from the last year's model.*" As discussed in the previous section (3.1.3), students felt appreciation for the opportunity to hear from the end user groups of the house.

Iterative testing was also mentioned as effective:

> *"So I think yeah, in hindsight the whole process was a benefit. The research, doing the evidence-based stuff, things that you wouldn't even think about. I keep going back to it, but the grab bar stuff. The fact that we had to stand there and continually test it, made us look at it a lot different than the stuff that we had on the 3D modelling software. Because you're like oh that would work! And then you put it in and you're like, that doesn't work. It doesn't make sense. It looks like crap. It hurts my hand. So I think that was a push in the right direction to take you into understanding the way people choreograph themselves in their own space."*

Students described how iterative testing fit into their design process:

> *"Whereas now, it's like before we touch anything, let's make sure this thing will work and we can draw it out and lay it out and see if this thing actually works and fits properly and then you go from there. Instead of just shimmying it in and stuff."*

Some students also mentioned the guest lecturers as being beneficial: *"I really enjoyed learning from the actual specialists who came and talked with us. I think it made it feel a lot more realistic and that there was actually a need to consider some of the medical requirements."*

The literature search assignment was also mentioned: *"There was that one exercise we did that I found super effective, which was when we went out and found our own papers, because everybody found a different paper, everybody found different findings."* Students felt a sense of ownership for the research, and throughout the semester would often advocate for certain design decisions, referencing the paper they found.

The components of the class that students said were ineffective were: barriers to implementing the research findings (including preconceived ideas about the design), guest lectures from experts, and too little time spent on research.

Students had conflicting opinions on the guest lectures. Some students mentioned the lectures as being particularly beneficial, but others considered them unnecessary. Ultimately, the lectures were likely effective, but perhaps overused, as articulated by this student:

> *"I think that there was way too many guest speakers and lecturers on it, and it got repetitive, and that should have been stuff that we did in the first two to three weeks. I don't think there was a point in doing it anymore after. I mean, we had people coming in to talk to us a month ago, and we'd already almost finished the design at that point. So the timing, and the fact that we had many people come in who spoke to us about the same thing. The overlap."*

Students also wanted more time spent on research. Specifically, students felt that while there was an emphasis on research at the beginning of the semester, this tapered off as the class progressed:

> *"I think it was really good in the beginning, like through January and a bit of February. Once we got into the millwork, that's sort of when things started to shift. […] that millwork just went on for six weeks, and I think the students sort of lost interest and that's sort of like, somehow things turned into more design and the mass customization of the cabinets and turning that into a system and the aging-in-place thing became less of a focal point. So if it could have kept going and stayed more research. I don't really know*

how you could do that, because at that point we kind of had the information already, so I don't know how you could keep it at the forefront of every decision. And again, the time constraint was a huge factor because we had to get the order in so that the parts could be here in time to assemble it.

The component most frequently mentioned by students as ineffective was the barriers to implementing the research findings. This topic was sufficiently salient to become its own theme, and will be discussed in section 3.2.2.

3.2 Application gap

3.2.1 Lack of research knowledge/experience

While the application gap has been characterized in the literature as a gap between research courses and design courses, these students seemed to have *no* research experience—rather than a gap, they faced a complete lack of research knowledge.

One student described the typical design process in their program, which usually did not involve research:

"Well definitely at the start, when we were working on the EBD, I thought that was really helpful. We don't usually get to do that in our program, and we make a lot of assumptions to things, because there's just so much to it. But when you have that research, it really helps back every decision you make, which is awesome, because in a critique, they'd be like, "Oh, why'd you do that?" and you'd be like "Uhhh, I don't know." So I think that's definitely helping. And then looking at, because there is a lot of research behind this specific age group that we're looking at, and that really helps make

> *our decisions for what we're going to do for, say it's a hand rail or the distance between things. That's kind of mainly the big points that I've been taking from this studio."*

Gross and Do (1997) observe that "the lack of formal methods in architectural design puzzles each generation of students entering studio; they learn the 'how to' skills through imitation of their teachers and more senior classmates." Gross and Do assert that "it is the rare teacher indeed who shows students how to follow a systematic method".

One student did express this 'puzzlement' and was disillusioned by their architectural education. They described their background in a different discipline and said:

> *"[In that discipline,] everything is extremely factual […] and every sentence in a textbook is a fact and you're constantly learning new information, whereas architecture is completely subjective and conceptual and I feel like I haven't really learned a lot in this three-year program. So I've just been sort of disappointed in the rigour of the profession. I thought that architecture was sort of like engineering in a way, like there was a lot to know, and it sort of turns out architects are more just like an artist and an engineer is really the person who figures it all out. And I hadn't really liked that."*

This student began their architecture education expecting it to be more research-oriented and systematic.

This research challenges the existing understanding of the application gap. While students in the class did encounter a traditional application gap, they first encountered a larger barrier: a lack of research knowledge. Typically, the application gap is

discussed as a gap between research classes/knowledge, and design classes/implementation (insert citation here). However, the students in this study knew very little about research. The challenge was not in getting them to use their existing knowledge of research methods, but rather, teaching them about research to begin with.

Some students expressed this lack of research knowledge as a product of the University of Calgary's architecture program. Gross and Do (1997) talk about the 'culture' of the design studio, and it seems that different schools develop different cultures. For example, one student talked about their undergraduate education at another school, where they said:

> *"There was a lot more exploration and focus on really researching what you're getting into. And here they don't seem to care that much about it until senior research studio, I guess. So that was something that we were expected to do on every project in my earlier years [at the other school]."*

This comment indicates that, in this student's experience, architecture education is not standardized and that different schools potentially differ in their cultures of research.

3.2.2 Frustrations with implementation

As students learned more about evidence-based design, they started to encounter the traditional application gap, where information about research is known, but it becomes difficult to implement in designs. Almost all students expressed disappointment that not all their research findings were incorporated into the final design of the house. Students viewed this outcome as occurring due to time constraints,

competing interests (such as an interest in creating a marketable product), and a lack of focus on research:

> *"I think just like, the focus throughout the studio, it kind of got lost. And it's definitely a huge time constraint too, because in the last few weeks everything just had to get decided and be done, which probably isn't how it would go in the next few phases, where they have more time to think about the specifics. I think the feedback was really good, and just having more time to incorporate it would have made it better."*

One situation highlighted the application gap students faced. Early in the semester, a student had found a paper detailing the declining eyesight of many older adults. One recommendation in the paper was that bold, contrasting colours be used to help older adults differentiate between spaces. However, the final colour scheme was chosen by the instructor, as he expressed worry about the direction the students would choose. He explained to me that choosing an appropriate colour scheme that looks good can be difficult and that he would consult with his colleagues (not the students) to choose the colours of the house. Many students were disappointed in the final colour scheme of the house because they felt it conflicted with the research evidence they found. For example, one student said:

> *"I feel like that's what happened, is we looked at the research earlier on, but didn't carry through with it to the end, and I think it shows in some aspects of the house. So I think that would be good, to really push for those, so everybody has a specific area that they need to look into, in my case it was colour, I think I should have had more of a say in*

what the colour would have been in the end. And that could have been different for someone else. But I think it really needs to continue and not just be a small portion."

However, students did not consider what other research findings might be in the literature regarding colour and small spaces, or interior design knowledge. They also did not consider what balance may need to be found; for example, the balance between a colour scheme appropriate for declining eyesight and a colour scheme that will be appealing in the market. While it may be true that older adults are able to see bold, contrasting colours more clearly, evidence-based design is more complicated than looking at a single study. This is noted by Martin (2009), who remarks on designers who read one study, and then base design decisions solely around that research. She calls this a "dangerous decision-making process" that many practitioners resort to due to their lack of research experience. Many students in the class likewise struggled to incorporate data from multiple sources, and indeed felt they were justified in wanting more contrasting colours in the home, based on one set of research. However, one student did seem to recognize that there might be justifiable reasons for the design choices that were made:

"I think a lot of the process sort of got pulled away from the students, too, so I think the learning was sort of limited in that way. I think some decisions were made out of the scope of the class even, like with people outside of the class. So, it would have been interesting to hear the conversations about the specific design decisions that were actually implemented, and how that relates to the whole aging-in-place model."

Another student even disagreed with the majority of the class and expressed agreement with the choice of colours:

> *"I know that people have been kind of upset, and bringing up that contrast example a lot. We've been talking about it a lot and looking at this house, frankly there isn't a lot of contrast. But I would probably disagree with what's being said. […] It's a fine research topic to have, like people only see contrast so let's put in a lot of contrast. But if you put in a lot of contrast into a building like that it's going to look totally horrible. Like you need to be really specific about what sort of contrast you bring in. And I know that [the professor] tried to, rather than making the floor another colour, he made the baseboards darker to see if that would work. I think that's a really intelligent way of trying to get at it, too. […] So I think we haven't lost anything yet in this project, it's just a matter of now researching and re-doing it. […] To say okay, maybe the baseboards work, and if they don't we'll try out something else."*

This student had a more nuanced interpretation of how to apply research to design, and also understood the iterative nature of evidence-based design. The darker floor boards were a deliberate design decision, with the intention to review whether localized contrasts in colour would be sufficient in subsequent testing of the Garden Loft.

These observations shed light on the experience of the traditional application gap. Other research on architecture education has looked at design classes that focused on evidence-based design as the main goal. For example, as discussed in the introduction, Haq and Pati (2010) described a class where the focus was on evidence-based design.

With this current study, the class was conceived and only later was a research component added as an experimental element. There were many other elements of the class, like the design-build aspect, the collaboration with an outside design firm (DIRTT), and the goal of future commercialization. Any one of these elements alone could have been the main component of a class; putting them all together meant that there were many competing interests and conflicting priorities.

These other elements are important aspects of architecture that must be addressed, especially in a professional context. In this way, the inclusion of evidence-based design as one-of-many goals mimics real-life situations. In a class focused solely on evidence-based design, students may not learn how to juggle demands that compete with research and evidence-based design. Even in the context of this study, students struggled with balancing these demands, as demonstrated by students' comments on the colour scheme of the house.

As well, there were epistemological reasons for the application gap seen in this class. Students found research that was largely measurable and objective. For example, most of the literature found by students was quantitative research (as opposed to qualitative). However, as Sancar notes, these findings are not necessarily easily applied to design, particularly when dealing with the idiosyncrasies of a project. This hearkens to a problem seen in evidence-based medicine. Critiques of evidence-based medicine sometimes cite its over-reliance on randomized controlled trials, which are considered the 'gold standard' of clinical evidence (Frenandez, et al., 2015). Guyatt, one of the early proponents of evidence-based medicine, and colleagues (2008) have even stated that

"high quality evidence does not necessarily imply strong recommendations, and strong recommendations can arise from low quality evidence", such as evidence from observational- and case-studies (Guyatt, et al., 2008). If students had looked beyond empirical research, they may have come to different conclusions about the best way to design the house. This was, again, highlighted by the process of choosing the colour scheme of the house. While the research literature recommended bright, bold colours for older adults, such a colour scheme was too overbearing for a small space like the Garden Loft, and a muted colour choice had the advantage of maintaining a domestic feel (as opposed to the bright colours of institutional spaces).

3.3 Changing architecture practice

We were interested to know if there would be longer-term effects of participating in a design/research class; specifically, if students would carry the evidence-based design principles they learned into their future practice as professional architects. Many students expressed a strong interest in continuing to use evidence-based design. One student offered this comment:

> *"Evidence-based design. I will definitely do all my research beforehand. Rather than, they teach architecture, like you go for your site visit and then you base everything on landscape. But that's only a small portion of it, like you actually want to learn more about the client and what they do. And you do ask questions and stuff, and it's kind of taught to you a little bit, but this is more in-depth like every little detail is designed, and I love that part of it. I'll use that for sure in the future."*

One student was particularly impressed by evidence-based design. They expressed a disappointment in other approaches to architecture, and even planned to leave the field upon graduation. However, they shared this:

> *"I haven't enjoyed my architectural education. So I don't plan to pursue it. But I think in a way I did really like learning from the professionals and I think like if I were to pursue architecture, like, that's something I would really want to pursue, is every time, if you're designing a school or a hospital, to have like feedback from people who work in that field. Like I think that that is so important. But then the parts that we sort of overlooked or ignored is one of the reasons I don't like architecture. Because I feel like sometimes as a consultant, architects seems to put design before actual facts. So I would, if I were to pursue architecture, I would try to focus more on the research."*

It is difficult to extrapolate exactly how this class will impact students' future careers. Many students expressed a desire to further engage in evidence-based design; however, even within the scope of this class, students seemed to falter when they encountered the application gap. One aspect of evidence-based design that seems most likely students will carry forward is awareness of the end-user. For example, one student said, "*And I think that's something that everybody should do now and I'm definitely going to take into my future practice, is before you start anything, research what is best for your client, what is best for the sort of the program that you're creating, and go from there.*"

An awareness of end-users is a very important aspect of evidence-based design, and if this approach is emphasized early in an architect's education, it may help evidence-based design avoid some of the pitfalls evidence-based medicine is beginning

to encounter. In 2014, Greenhalgh, Howick and Maskrey published an article in The British Medical Journal, entitled 'Evidence-based medicine: A movement in crisis?'. Cited over 500 times in less than three years, it has sparked debate in the medical community. Greenhalgh, Howick and Maskrey argue, in part, that evidence-based medicine overemphasizes "algorithmic rules" at the expense of clinicians and patients collaborating in shared decision making, and that it is especially problematic for patients with comorbidities. Based on these issues, Greenhalgh, Howick and Maskrey advocate for a return to what they call "real evidence-based medicine". They state that real evidence-based medicine "(1) makes the ethical care of the patient its top priority; (2) demands individualized evidence in a format that clinicians and patients can understand; (3) is characterized by expert judgment rather than mechanical rule following; (4) shares decisions with patients through meaningful conversations; (5) builds on a strong clinical-patient relationship and the human aspects of care; and (6) applies these principles at community level for evidence-based public health".

As evidence-based design is a newly emerging approach, design practitioners are uniquely placed to learn from the progression of evidence-based medicine. Brown and Corry (2011) advocate for practitioners who are willing to address these potential pitfalls from the start. For example, Bensing (2000) recommends "strengthening the patient-centeredness of evidence-based medicine"; this is an approach that could be applied to evidence-based design, through a focus on end-users. The Garden Loft itself demonstrates the usefulness of this approach. Not only did students appreciated hearing from end-users, but the end-users themselves felt that their comments made a

difference. In a later project, the Garden Loft was evaluated by research participants who previously evaluated the Laneway House. These participants felt unanimously that the new design was an improvement, and were especially pleased to notice when their own suggestions had been implemented. New participants also responded very positively to the house (Wiley, 2016).

3.4 Implications

This research demonstrates the utility of including a research component in a design studio class. The research component was successful in introducing students to evidence-based design and the analysis indicated that students planned to continue using elements of evidence-based design in their future practice. Our approach also demonstrated that evidence-based design can be introduced to students through *components* of a class; that is, the class does not need to be developed solely for the purpose of teaching evidence-based design.

Indeed, one advantage of this approach is that it can teach students how to balance the competing demands that may arise when engaging with evidence-based design in a professional practice. This is a valuable lesson, as we have learned from medicine. Siddhartha Mukherjee, a cancer physician and researcher, says, "The greatest clinicians who I know […] understand, almost instinctively, when prior bits of scattered knowledge apply to their patients—but, more important, when they don't apply to their patients. They understand the importance of data and trials and randomized studies, but are thoughtful enough to resist their seductions" (Mukherjee, 2015).

This approach, however, does not comprehensively educate students about evidence-based design and is not sufficient on its own for equipping students to be evidence-based design practitioners.

Chapter 4 … Limitations, Future Research and Recommendations

4.1 Limitations and Future Research

As with any qualitative work, our research was limited in its scope and generalizability. We engaged with one class, of limited sample size, at one university. While the students in the study came from different backgrounds and had varied reasons for joining the class, they may not adequately represent the general population of architecture students at the University of Calgary.

This study also does not represent the experience students may have at a different school. Even participants in the study talked about differences between architecture programs at different universities in Canada. There may be even more variation in programs outside of the country.

There is also variation between classes within a program. One theme that arose from our data was the idea that this studio was different from others. This was partially because of the research component, but this studio also included a design-build element and a strong emphasis on professional practices.

Future research could examine research components implemented in different architecture classes and at different universities. Wide exploration of the different cultures surrounding research at different universities is needed. Universities with a stronger emphasis on research could be looked to as examples for implementing evidence-based design into architecture education.

As well, our research looked at one approach to teaching evidence-based design; introducing research components to one class not solely focused on research. Other

approaches, such as a class focused on evidence-based design or multiple research classes within an overall program, may also yield insights on the education of architecture students and should be researched.

4.2 Recommendations for the education of architecture students

While our study is limited in its generalizability, we can make some high-level recommendations for architecture education, with the caveat that these recommendations may not be suitable for all programs.

4.2.1 Offer students a variety of studio experiences

Students in our study praised this class for its novelty and unique aspects. They felt previous classes were homogenous in nature. There may be opportunity for architecture schools to evaluate their programs of study and implement more diverse classes, depending on their teaching goals.

4.2.2 Classes that mimic 'real-world' situations may be useful, but 'real-world' solutions should be taught as well.

Through this class, students received first-hand experience of competing demands in the professional workplace. Students knew that the class was focused on a project meant for eventual commercialization. They found this interfered with implementing evidence-based design findings, and found this frustrating. However, this allowed for unique learning opportunities that may have been missed in a more theoretical or academic class. Because of these frustrations, students may be better equipped for the realities of architectural work beyond their education.

Despite this benefit, the class may have benefitted more from a stronger emphasis on communicating 'real-world' solutions, as expressed by the one students who said they wished for more insight about why the instructor made a certain design decision.

4.2.3 Ensure students have a foundation of basic research knowledge

One of the largest obstacles faced by students when engaging with evidence-based design was a lack of research knowledge. This was a near-universal experience, despite students' different educational backgrounds. We attempted to provide the basic knowledge students needed to engage with evidence-based design. However, we observed that it is difficult to provide a strong foundation of research knowledge within the confines of one class with multiple objectives. Based on existing research on the application gap, we also know that teaching students about research in a lecture class does not adequately prepare them to use research in a design class. Given these two issues, the best approach may be to implement brief research components in every design class a student takes. Research components at the beginning of the degree program can be relatively simple (for example, learning how to use library resources and find research literature) and then increase in complexity as the students progresses through their program. This approach also addresses students' desires that more design classes include research components.

4.2.4 Structure research components effectively

One lesson learned from our study is that research components need to be effectively structured and budgeted time within the class. While the beginning of the

class had a strong emphasis on research, this decreased as other demands took precedence, such as building the house. This shifting of priorities does mimic real-life situations, which we already discussed as beneficial; however, the research process by nature is on-going, and efforts should be made to ensure that while research might move down the priority list, it is never forgotten completely. This could be accomplished through careful planning. At the beginning of the semester, we scheduled lectures and activities around evidence-based design. However, as the semester progressed, the research components became more informal. These informal arrangements were often postponed or neglected due to pressing demands with construction and so forth. More formal, concrete plans may help combat this issue.

4.2.5 Offer students engagement with real-life end users

We would be remiss to not emphasize the importance of engagement with end-users. Students repeatedly mentioned this as one of the most beneficial and interesting aspects of the class. Ensuring engagement with end-users may also help the field of evidence-based design avoid some of the pitfalls of evidence-based medicine. The medical community is now pushing for a move to user-centric evidence-based medicine. By emphasizing the user from the beginning of an architect's education, the relatively new field of evidence-based design has the opportunity to begin as a user-centric field.

While facilitating direct interaction between students and real-life users may be difficult due to ethical concerns, we demonstrated that even indirect forms of interaction (anonymized transcripts of interviews, in this case) can be effective. It is

possible that architecture schools could build relationships with community members and make direct interaction feasible, as well.

4.3 Conclusions

Evidence-based design is a growing field and many believe it is the future of architecture. However, similar to the development of evidence-based medicine, the architecture community faces several obstacles in fully integrating evidence-based design into architectural practice. These obstacles can range from individual problems, such as design firms facing limited resources, to more cultural problems, such as the education of architecture students.

The field of evidence-based design is uniquely positioned to learn from the evolution of evidence-based medicine. Criticisms of evidence-based medicine ask questions about what qualifies as evidence and how to weigh research against expert judgment and individualized care. Some strategies to cope with these conflicts include the education of medical students and focusing on patient-centric medicine, as discussed earlier.

Working to apply ideas from medicine to evidence-based design, our research focused on the implementation of a simple research component in a design studio class. We demonstrated that, with some limitations, this is an effective way to engage students with evidence-based design.

We also demonstrate the importance of a balanced approach. Siddhartha Mukherjee (2005) calls medicine "a discipline that is still learning to reconcile pure knowledge with real knowledge". Architecture must take this task on as well. As

evidence-based design is integrated into the field, it must be balanced with consideration of art, individual client needs and desires, and the expert judgment of architects. As Trousseau (1869) says, "…the worse man of science is he who is never an artist, and the worst artist is he who is never a man of science." Through carefully structured education programs, architects can be taught to be both artists and scientists.

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Appendix

List of interview questions asked to participants:

End of Semester Semi-Structured Interviews

1. Why did you take this class?
2. What do you feel are the biggest lessons you learned from this class?
3. How has this class changed your architectural practice?
4. Regarding research and evidence-based design, what do you feel you learned from this class?
5. What are your opinions about including a research component in this type of class?
6. What made the research component in this class effective and/or ineffective?
7. What did you think about the ratio between the research component and the design aspects?
8. Are there any other comments you would like to make about this class?